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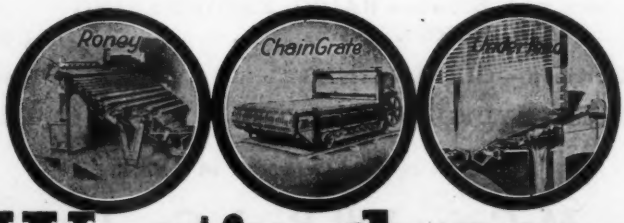

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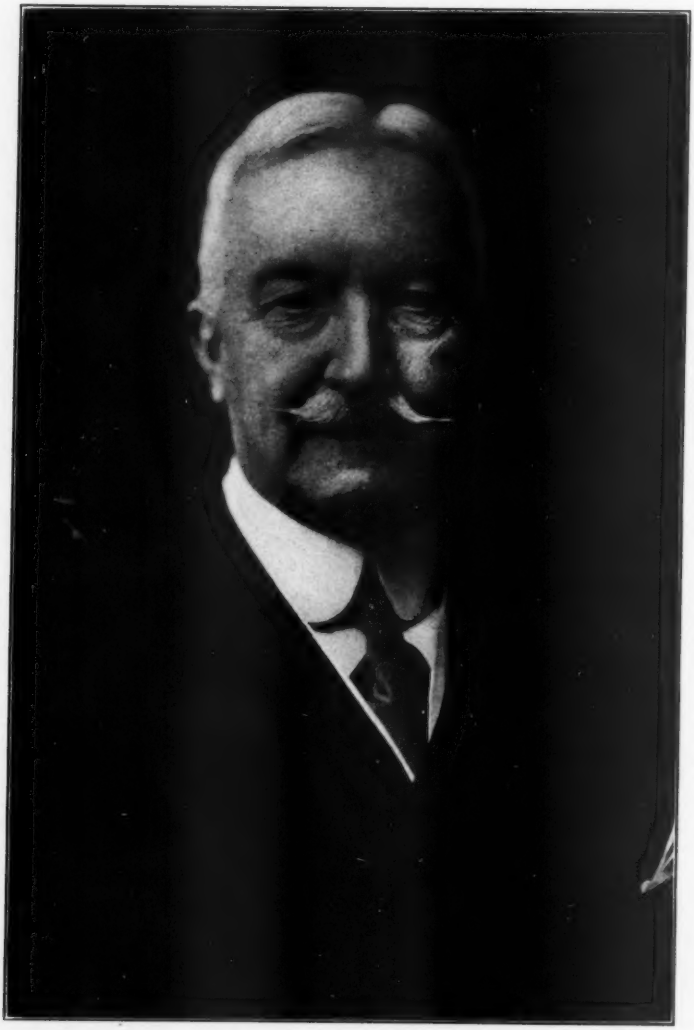

DEAN MORTIMER L. COOLEY.

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MORTIMER E. COOLEY.*

Mortimer E. Cooley was born March 28, 1855, at Canandaigua Township, Ontario County, New York. He spent three terms in the old Canandaigua Academy. He boarded himself two winter terms and walked from his home, three and one half miles away, one spring term, "doing the chores"

* *Michigan Technic,* December, 1919.

morning and evening. That and taking care of the garden Saturdays were the conditions which secured for him the unusual privilege of being excused from regular farm work. For two winters he taught district school and in that way earned the money needed to pay his expenses at the Academy and to finance his next step towards an education.

The four-year course for cadet engineers was established in 1874 at the U. S. Naval Academy and appointments were open to competition. Of some seventy candidates who tried the examination, twenty-five were appointed; Mortimer Cooley passed seventh and four years later graduated seventh in a class of fourteen. He took an active part in athletics, was captain of his class crew, and stood high with the foil and broadswords.

On graduating from the Naval Academy, he was assigned to the U. S. S. *Quinnebaug*, which sailed in the fall of 1878 to the Mediterranean. He returned on the U. S. S. *Alliance* a year later and on Christmas day, 1879, was married to Carolyn Elizabeth Moseley, of Fairport, New York.

Cadet Engineer Cooley was assigned to the Bureau of Steam Engineering at the Navy Department. In June, 1881, he was examined and promoted to assistant engineer and in August was ordered to the University of Michigan to teach steam engineering and iron shipbuilding. At the end of three years, on request of the regents, his detail was continued a fourth year. Being then detached and ordered to the Pacific Station, the regents conferred on Assistant Engineer Cooley the honorary degree of Mechanical Engineer and invited him to resign and accept the chair in mechanical engineering. This he did, his resignation taking effect December 31, 1885. It was with a great deal of regret that he resigned, as he was in love with the Service. There was at the time no prospect for any great increase in the naval force, and it seemed to him the opportunity for real work afforded him at the university ought not to be declined.

He has been dean for fifteen years, having been appointed

in February, 1904. The Michigan Agricultural College conferred on him the degree of LL.D. in 1907, and the University of Nebraska the degree of Eng.D. in 1911. When he came to the university there were but sixty or seventy engineering students out of a total of about thirteen hundred in the university, and the entire technical work in engineering was done in seven rooms at the south end of the main university building. The first engineering laboratory was built the winter after he came. It was a two-story brick veneer building 24x36 feet, costing $1,500 and the equipment $1,000. In it Professor Cooley himself taught forging, pattern-making and machine-shop practice. It was styled by his colleagues "the Scientific Blacksmith Shop." It was the beginning of an effort, now altogether general, to give to engineering students, while in college, some practical knowledge of the materials and processes used in the execution of engineering projects.

Dean Cooley was from 1895 to 1911 the chief engineer officer of the Michigan State Naval Brigade and is now a retired officer in the Brigade.

Following his return to the University after ten months' service in the Spanish-American war, Professor Cooley was invited by the Citizens' Committee of Detroit, of which Governor Pingree was chairman, to appraise the power plants, rolling stock and stores and supplies of the Detroit street railways, which the city was contemplating purchasing. It was a hurry job and was done in a hurry. The appointment was made on Friday, the staff organized Saturday and the report submitted the following Saturday, covering $2,000,000 of property. The following year, 1900, at the request of Governor Pingree, the Board of State Tax Commissioners, and the Board of State Auditors, Professor Cooley undertook to appraise the specific tax paying properties of the State of Michigan, which included the Steam Railroads, the Telegraphs, the Telephones, the Plank Roads and the River Improvements.

Michigan's pioneer work in valuation of large public utility

properties was soon followed by other states. First among them was Wisconsin in a valuation of her steam railroads. Substantially the same methods were employed as in Michigan. Professor Cooley was consulting engineer.

Nor has Professor Cooley neglected opportunities to serve in other capacities. He was for a time chairman of the Board of Fire Commissioners, and president of the Common Council in AnnArbor in 1890–91. He served on the Board of Awards for the World's Fair in Chicago in 1893, and for the Pan-American Exposition in Buffalo. He has for twenty-five years served as mechanical expert in patent cases, and testified many times on mechanical matters before juries and commissions. He was for five years (1907–1912) chairman of the Block Signal and Train Control Board of the Interstate Commerce Commission.

Professor Cooley is a Fellow of the American Association for the Advancement of Science, member of the American Society of Mechanical Engineers, American Society of Civil Engineers, American Institute of Consulting Engineers, Franklin Institute, Society for the Promotion of Engineering Education, Society of Naval Engineers, Michigan Engineering Society, Detroit Engineering Society, Sigma Phi, Tau Beta Pi, Sigma Xi, the Army and Navy Clubs in Washington and in New York, the Detroit Club and Yondotega Club in Detroit.

THE HYPHEN IN ENGINEERING LITERATURE.*

BY F. STURGES ALLEN,

General Editor, Webster's New International Directory.

The purpose of this paper is to examine the development of the use of the hyphen in engineering literature.

To this end I have restricted my special researches to engineering literature. Yet it is obvious that engineering topics are so diversified in their nature and so wide in their scope that engineering literature cannot be—neither would it desire to be—divorced either from the literature of the physical sciences in general or from pure literature itself. In its hyphen characteristics it closely resembles the literature of the physical sciences in general, of the industries and the trades, of the newspapers, and of much other miscellaneous writing,—using rather more two-noun combinations than some of the sciences, about the same as the American newspapers, and fewer than much of the literature of trade and industry.

The uses of the hyphen in forming compound or derivative words may be broadly divided into three classes: I. The use in forming derivatives from words by adding to them a prefix or suffix, as *ante-, anti-, be-, dis-, hyper-, in-, non-, semi-, sub-, super-, supra-, ultra-, un-,* etc. There is no material difference of opinion as to the principle regarding the use of the hyphen in such words, and in many cases whether the hyphen is used or not is not a matter of animadversion or comment.

II. The use which has been called "grammatical," where the hyphen serves to connect two or more words used together as a part of speech to govern or limit a following word or group of words, as in *road-mending* operations, an *out-and-out*

* This paper provided by Committee No. 20, Standardization of Technical Nomenclature.

opponent, a *two-horse* wagon, an *ill-built* house, to *short-circuit* a battery.

This use of the hyphen is comparatively recent, and has been fairly uniform from the beginning: whether it is observed or not in any particular instance, it is generally agreed that in such combinations the hyphen should be used. The fact that the rule is not always followed, even on the same page, I interpret as being due rather to the incapacity of the mind always to observe even the less subtle distinctions than to the existence of any question as to what is the proper form of the combination.

III. The use in forming compound nouns by the combination of noun with noun or of adjective with noun, as *airplane, beehive, blackbird, blackguard, steamship, windmill, lifeboat* or *life-boat, footboard* or *foot-board, motorman* or *motor-man, crank pin, crank-pin,* or *crankpin, goldenrod, horse power, horse-power,* or *horsepower, connecting rod* or *connecting-rod, cantilever bridge, gravity cell* or *gravity-cell, storage battery* or *storage-battery.*

This list of course could be extended indefinitely; I have chosen here merely a few typical examples. Whether or not to use the hyphen in words of this class is the main question concerning the use of the hyphen about which there is any difference of opinion among modern writers and printers. The number of compound nouns formed by the union of adjective (other than the participle) and noun is so small and their form generally so well fixed by a compelling usage that they may here be left out of account.

Prior to about 1850 engineering literature, as well as the literature devoted to the other physical sciences and the industries (with which engineering literature must be classed), was little more than a part of the general literature of the language, and there was among most of its authors a conscious effort to conform its diction to that of pure literature. There had then arisen no great body of technical literature with, more or less, a method and press of its own. The number of

noun combinations made by juxta position of the noun with noun or of participle or gerund in *-ing* with noun was small as compared with those to be found in our present literature of that kind.

Therefore this class of words had received but little attention, and their place in the language was not clearly understood: hence, we see them confused with such ordinary adjective noun combinations as *Christian name,* which is mentioned as a compound by the early grammarians, as Lindley Murray and Goold Brown. In the early dictionaries, including *Webster's Dictionary* as late as the edition of 1864 and *Worcester's Dictionary* down to the last edition, we find hyphened such compounds as *bitter-apple, bitter-cucumber, black-iron, Black-Monday, black-martin, black-vomit,* the adjective phrases being uniformly given as hyphened compounds in the vocabulary.

The very modern notion of some that nouns cannot be used adjectively, however, seems not to have entered the heads of these early writers, for both Murray and Brown, with various others, say explicitly that the noun can be used adjectively, and confirmation of this is not wanting in the works of our best modern philologists and grammarians. Thus, to mention but one instance, John Earl, in his "Philology of the English Language," says (p. 420): "Thus, *brick* and *stone* are substantives; but mere position before another substantive turns them into adjectives, as *brick house, stone wall;* and the latter when condensed into a compound substantive, *stone-wall,* may again by collocation make a new adjective, as 'Stone-wall Jackson.' Thus we speak of *garden flowers* and *hedge flowers:*

> 'Near yonder copse, where once the garden smiled,
> And still where many a garden flower grows wild.'
> Oliver Goldsmith.

In some instances a substantive, through long standing in such a position, has acquired the adjectival habit exclusively, as *milch,* in the expressions 'milch cow,' 'milch goat.'"

But whether we call the limiting noun an "adjective" or not does not affect the question as to whether the noun is used as a qualifying or attributive word before another noun without a hyphen between the two.

For the purposes of this paper I examined with care more than twenty of the standard books published about 1850 on the sciences and arts. The results can here only be briefly stated. I found them to consist rather definitely of two groups: (1) those which use the noun freely (for those days) to limit another noun, using very few hyphens; (2) those, a smaller group, which make fewer combinations of noun with noun, and use hyphens in very many of them.

The extreme system of hyphenating even adjective compounds has now been completely abandoned in the dictionaries. But the use of the hyphen to join nearly every two-noun combination and many combinations of noun with *-ing* forms (participles or gerunds) has been retained to the present day in one (the *Standard Dictionary* of Funk & Wagnalls) of the two chief current one-volume dictionaries. *Webster's Dictionary* broke away from the system in the edition of 1890, called *Webster's International Dictionary*, and has never gone back to it. In the analysis made later I shall designate the first work as "F" and the second as "W."

For the purpose of having for this paper some definite information as to what present engineering use is, I have examined seventeen different works* on subjects connected with the science of engineering, and have listed all the noun

* The books examined were chosen as they were run across in order to give a fair selection. They are, briefly designated: Audel, *Pumps and Hydraulics* (1905); Bedell, *The Transformer* (1896); Crocker, *Electric Lighting* (1906); *Elec. Railway Journal*, July, 1919; *Engin. and Mining Journal*, July, 1919; *Engin.-News Record*, July, 1919; *Everyday Engin. Mag.*, July, 1919; Fleming, *Elec. Wave Teleg.* (1906); Gerhard, *Water Supply, Sewerage, and Plumbing* (1909); *The Iron Age* (1918); Peake, *Hydraulics* (1906); Rogers *Pumps and Hydraulics* (1905); Tonge, *Coal Mining* (1906); Waddell, *Bridge Engineering* (1916); Wilson, *Hydraulic and Placer Mining* (1903); and *Mine Ventilation* (1900); Young, *Complete Motorist* (1904).

combinations occurring on pages taken entirely at random, noting those of noun with noun and of *-ing* forms with nouns where the form might be in question.

About the same number of combinations were listed from each book, making a total of 1024 combinations, with 80 more in which the first element was of a kind that usage now rather uniformly treats as an adjective, as *average, bottom, top,* and *brass, iron, steel, lead, aluminum, mercury,* or other name of a substance used with the sense of "made of," as in *average loss, bottom member, steel web, aluminum casting.*

Of the 1024 combinations (representing just that class of combinations hyphened in F and usually given as two words in W) 55 were solid words in form, 135 hyphened words, and 834 two words. All of the 80 combinations with *average, bottom, brass,* etc., were two words.

TABLE I.

39 SOLID-WORD COMBINATIONS OF MONOSYLLABLES.

Words as in List.	As in F.	As in W.	Words as in List.	As in F.	As in W.
airplane		( )	lifeboat	-	( )
airway	( )	( )	lightship	-	( )
beehive		( )	limestone		( )
crankcase		# or ( )	manhole		( )
crankshaft	-	# or ( )	mouthpiece		( )
dashboard		( )	network		( )
dovetail		( )	notebook		( )
fireman		( )	railroad	-	( )
flagman		( )	railway		( )
flagpole		( )	roadway		( )
flywheel	( )	( )	snowshoe		( )
footboard	-	( )	steamship		( )
footstep	-	( )	stovepipe		( )
gearbox	-	( )	trainman		( )
gooseneck	( )	( )	viewpoint	-	( )
handwheel		( )	washpan		( )
hedgehog	( )	( )	wayside		( )
horseshoe		( )	windmill	( )	( )
keyboard	( )	( )	workman	( )	( )
keyway	( )	( )			

I compared all the listed combinations with the two dictionaries which typify the one (F) the usage favoring the hyphen, the other (W) the usage favoring its omission. It

would be interesting as well as profitable to give the lists in full; but space forbids. I will, therefore, give only those combinations found in one or the other of the dictionaries, and these combinations are typical of the entire list. I have grouped together (1) the combinations of monosyllables, (2) the combinations of dissyllables with monosyllables or dissyllables, and (3) the combinations in which one element is a trissyllable. In the columns the symbol [♯] means that the combination is given as two words (unhyphened) in the dictionary under which the symbol occurs, [-] that it is hyphened, and [⁀] that it is a solid word (with the elements joined and no hyphen). The words in the columns appear as noted in the list.

This table of 39 solid words shows no great difference in treatment between the two dictionaries. Only two of the 41 solid words in the complete list were not to be found in either of the dictionaries; these two words are *bridgework* and *kneeslide*. It is plain, therefore, that the solid-word form is sparingly used for combinations and only where the feel for it is strong and very general. The chief characteristic of the combinations seems to be that the individuality in sense of the thought elements is pretty much lost in the word as the name of a simple thing. This we see more perfectly exemplified in such terms as *breakfast, shipshape, whitewash;* in *daisy, woman, manly,* etc., the elements are etymologically so obscured that they can be discovered only by historical methods.

This table of 40 hyphened combinations of monosyllables shows at once a decided difference in treatment by the two dictionaries, the one giving most of them as hyphened, the other the majority in the two-word form. The variations to the solid-word form [⁀] evidently were made in an effort to conform to usage. In the list as a whole the thought elements involved in the combinations are felt individually by the mind more than they are in case of the words in the first list.

Of the hyphened-word combinations of monosyllables in the complete list, 24 are not in either dictionary. A few of these

are: *air-vein, arch-bridge, bridge-steel, coal-dust, coal-seam, fan-drift, field-core, guide-crown, tail-sluice.* The number (64) of hyphened combinations in and not in the dictionaries shows that the hyphened-word form is more freely used than the solid-word form.

TABLE II.

40 HYPHENED-WORD COMBINATIONS OF MONOSYLLABLES.

Words as in List.	As in F.	As in W.	Words as in List.	As in F.	As in W.
air-box	-	#	head-frame		( )
air-gap	-	#	head-race		( )
air-valve	-	#	hill-side	( )	( )
bed-plate	-	( ) #	marsh-gas	( )	#
bed-rock	-	( )	pin-hole	( )	( )
cap-piece	-	#	pipe-line	( )	( )
car-mile	-	#	sand-bar		
coal-gas	-	#	sand-box		
cog-wheel	-	( ) #	side-plate		
crank-pin	-	# or ( ) ( )	slide-rule		#
drive-pipe		( )	sluice-box		
eye-bar	-	#	snow-line		#
fire-damp	-	#	stand-pipe		( )
fly-wheel	-	# ( )	sway-brace		( )
force-pump	-	#	tail-race		( )
gas-pipe	-	# or ( )	ton-mile		#
guide-blade		#	tram-car		( )
guide-ring	-	#	waste-gate		( )
hand-hole	-	( )	wheel-base		#
hand-wheel		( )	wheel-work	( )	( )

This table too shows a striking difference between the dictionaries, F hyphening nearly all the combinations, W having nearly all in the two-word form.

It is noticeable that this table includes a considerably larger number than either of the two preceding tables; but a still more significant fact is that besides the 55 combinations in the dictionaries the complete list includes 102 combinations not in either, making 157 such combinations in all. A few of those not in F and not in W are: *air plane* (= plane of air, not aeroplane), *arc type, arch bridge, ball float, bank sand, belt drive, spark gap.* Comparing the complete lists of the three forms (⌒, -, #), we find 157 #, 64 -, and 41 ⌒, showing that the two-word (#) form is the one most freely used, there being

nearly three times as many # (157) as there are hyphened (64). From this we can see that there is a strong tendency (at least in engineering works) to use the two-word form. Why the hyphen is used in the words in the previous list and not in those in this must be due merely to the personal idiosyncrasies of the users; no other reason is to be discovered.

TABLE III.

55 COMBINATIONS OF MONOSYLLABLES, IN THE TWO-WORD FORM.

Words as in List.	As in F.	As in W.	Words as in List.	As in F.	As in W.
air gap	-	#	road work	-	
air pump	-	#	rock shaft	()	()
air tap	-		screw cap	-	
arc lamp	-	#	screw joint	-	
ball race	-		sheet iron	-	
ball valve	#	#	slide rule	-	#
brake shoe	-	#	slide valve	-	#
breast wheel	-	#	slip ring	-	#
crank shaft	-	# or ()	sluice gate	-	#
drain pipe	-	()	soil pipe	-	#
drift wood	()	()	spark ball	-	
drill press	-	#	spark gap	-	#
force pump	-	#	steam chest	-	#
gas shield	-	#	steam pipe	-	#
gas works	-	#	steam pump	-	#
guide blade		#	steam trap	-	#
guide rope	-	#	steam mill	-	#
hand drill		#	sway brace	-	#
head gate	-	#	tail stock	-	#
lathe work	-	#	test tube	-	#()
lock nut	-	#	valve gear	-	#
lift bridge		#	valve rod		#
oil hole	-	#	valve seat	-	
pin hole	()	()	vent plug	-	
pipe line	#	#	waste pipe	-	
pole piece	-	#	wheel base	-	#
pump rod	-	#	worm gear	-	#
rain water	-	#			

Of the two-word forms, *air gap, arch bridge, bridge steel, coal dust, force pump, guide blade, guide crown, pin hold, pipe line, slide rule, sway brace, wheel base,* also occur as hyphened in the lists,—leaving 145 that occur only in the two-word form. *Crank shaft* alone occurs also as a solid word.

Of the hyphened forms only *fly-wheel* and *hand-wheel* occur as solid words.

TABLE IV.

14 SOLID-WORD COMBINATIONS OF A DISSYLLABLE WITH A MONOSYLLABLE OR A DISSYLLABLE.

Words as in List.	As in F.	As in W.	Words as in List.	As in F.	As in W.
gunmetal	-	#	piledriver	-	#
gunpowder	( )	( )	policeman	( )	( )
horsepower	-	# or ( )	stockholder	( )	( )
motorman	-	( )	tidewater	-	( )
ironstone	( )	( )	typewriter	( )	( )
orebody	-		waterway	( )	( )
passageway	( )	( )	waterworks	( )	( )

This table includes all the solid-word combinations of this class found. The fact that the list is so small and includes so

TABLE V.

35 HYPHENED COMBINATIONS OF A DISSYLLABLE WITH A MONOSYLLABLE OR A DISSYLLABLE.

Words as in List.	As in F.	As in W.	Words as in List.	As in F.	As in W.
air-chamber	-	#	steam-engine	-	#
ampere-turn	-	#	stuffing-box	-	#
contact-maker	-	#	time-table	-	-
cutter-bar	-	#	trundle-wheel	-	
exhaust-valve	-	#	water-closet	-	
field-magnet	-	#	water-course	( )	( )
field-winding	-	#	water-gage	-	#
gas-engine	-	#	water-gate	-	#
gusset-plate	-	#	water-jacket	-	#
heat-engine	-	#	water-jet	-	#
horse-power	-	# or ( )	water-line	-	#
living-room	-	#	water-organ	-	#
motor-car	-	#	water-pipe	-	#
piston-rod	-	#	water-rain	-	#
plate-girder	#	#	water-supply		#
power-house	-	#	water-wheel	-	#
pressure-box	-	#	weather-vane	-	#
side-cutting	-				

few words not given as solid in the dictionaries and no word not in the dictionaries shows that the solid-word form is

seldom used for combinations of words of more than one syllable, and then only where the feel for its use is strong.

Only the words *horsepower* and *stockholder* occur, in the list, in any other form; the first we find also as two words and hyphened; the latter also as two words. The similarity of treatment in the two dictionaries is noticeable.

In this table the contrast between the two dictionaries is conspicuous. It is also noticeable that there is but one word, *watercourse* given as a solid word in both dictionaries, showing, like Table IV, that there is little tendency for combinations of this class to become stereotyped solid words. Besides the terms shown above there are in the complete list 34 not in either dictionary, making 69 in all.

Besides the 94 unjoined combinations in this table, there are in the complete list 298 combinations not to be found in either dictionary. A few of these latter are: *air inlet, airplane motor, arc discharge,, tappet valve, wage question, outlet valve, oil reserve, ore reserve, binder screw.* No distinct difference can be drawn between them and those in the table above, but one has the general feeling that most of those not in the dictionaries are more obvious in meaning and less imply a conventionally restricted sense than do those that are.

We find that of the two-word forms 14 occur also in the hyphened-word form: *brush holder, contact maker, cutter bar, fan chamber, field magnet, gas engine, horse power, piston rod, rubbing surface, steam engine, water line, water pipe, water supply, water wheel.*

We find two combinations also in the solid-word form: *horse power* and *stock holder.*

Comparing the combinations of the class shown in tables IV, V, and VI, we are impressed by the fact that nearly six times as many (392) are in the two-word form as are hyphened (69), and that 94 of the two-word combinations are in the dictionaries (in F mostly hyphened, in W mostly as two-words), and of the hyphened combinations 34 are in the dictionaries (in F mostly hyphened, in W mostly as two words).

TABLE VI.

94 COMBINATIONS OF A DISSYLLABLE WITH A MONOSYLLABLE OR A DISSYLLABLE.

Words as in List.	As in F.	As in W.	Words as in List.	As in F.	As in W.
air cooling	-	#	nickel steel	-	#
angle iron	-	#	packing ring	-	#
ball bearing	#	#	parlor car	-	#
beehive oven	#	#	phosphor bronze	-	#
bevel gear	-	#	pillow block	-	#
bevel wheel	-	#	piston rod	-	#
blast furnace	-	#	power current	-	#
brush holder	-	#	power factor	-	#
buffer block		#	pressure gage	-	#
carbon steel		#	pump barrel	-	#
carriage spring	-	#	punching machine	-	#
coaster brake	-	#	radius vector	#	#
contact maker	-	#	rocker shaft	-	#
contour map		#	rolling mill	-	#
copper loss	#	#	sea level	-	#
cotton press	-	#	service pipe	-	#
country rock	-	#	spelter solder	-	#
cutter bar	-	#	spray nozzle	-	#
datum level	-	#	sprocket wheel	-	#
driving wheel	-	#	steam boiler	-	#
drop hammer	-	#	steam engine	-	#
eddy current		#	steam fitting	-	#
exhaust part	-	#	steam turbine	-	#
exhaust steam	-		stock holder	-	( )
fan chamber		#	stock market	-	#
field magnet	-	#	suction pipe	-	#
field winding	-	#	suction primer	-	#
filter bed	-	#	suction valve	-	#
flange coupling		#	sumping shot	-	#
friction clutch	-	#	surface gage	-	#
friction roller	-	#	swaddling clothes	#	#
gas engine	-	#	thrust bearing	-	#
hand lever	-		toggle joint	-	#
heater coil	-		traction engine	-	#
horse power	-	# or ( )	tumbler gear	-	#
impulse turbine	#	#	wagon train	-	#
inlet valve		#	walking beam	-	#
iron foundry	-		water hammer	-	#
iron loss	#	#	water level	-	#
iron ore		#	water line	-	#
iron works			water pipe	-	#
lead pencil	-	#	water side	-	( )
lead sulphate		#	water wheel	-	#
linseed oil	-	#	winter time	-	#
machine screw	-	#	working barrel	-	#
milling machine	-	#	zinc choloride	#	#
molding sand		#	zinc sulphate	#	#

From this it is clear that the usage of the seventeen books examined very decidedly favors the two-word form, and I think those books are typical of general engineering usage.

There is not room here to make any analysis in order to discover some principle of distinction between the two forms. I have, however, made an elaborate but fruitless comparison; no such principle was found.

TABLE VII.

3 HYPHENED COMBINATIONS OF A TRISYLLABLE WITH ANOTHER WORD.

Word as in List.	As in F.	As in W.	Word as in List.	As in F.	As in W.
connecting-rod	-	#	opera-glass	-	#
heat-energy	-	#			

No solid-word combinations having at least one trissyllable were found and the three given above are all that occurred hyphened. Of these *connecting-rod* and *opera-glass* occurred also as two-word combinations.

TABLE VIII.

29 TWO-WORD COMBINATIONS OF A TRISYLLABLE WITH ANOTHER WORD.

Words as in List.	As in F.	As in W.	Words as in List.	As in F.	As in W.
air compression		#	illuminating gas		#
cantilever bridge	#	#	inductance coil	-	#
caterpillar tractor		#	induction coil	-	#
canary wood	#	#	motor generator	-	#
collector ring		#	motor interruptor	-	#
condensing engine	#	#	platinum metal	#	#
connecting rod	-	#	power component	-	#
current density	-	#	resistance box	-	#
cylinder condensation	-	#	resistance thermometer		#
fire department	#	#	riveting machine	#	#
flux density		#	steam cylinder	-	#
gravity cell	-	#	storage battery	-	#
hammer break	-	#	surface condenser	#	#
hedgehog transformer	#	#	vector quantity	#	#
hydrogen peroxide	#	#			

In this table W gives all the combinations in the two-word form, and F gives a much larger percentage so than in the prevous tables.

In the complete list there are 285 combinations of this class, but those in tables VII and VIII are the only ones given in the dictionaries. The aversion of engineering usage to the hyphen in compounds of this class is still more decided than in case of the previous forms.

There seems to be but two conclusions that are clearly to be drawn from all these samples, (1) that two-noun combinations are freely used in modern engineering literature, and (2) that most of such combinations have the two-word form.

I have made further comparisons which there is no room here to state; but I may say that from the whole list it is plain: (1) that usage does not in the majority of cases observe the rule that a hyphen shall be used where the latter element denotes action upon the first, as in *stock holder, air compression, cotton press;* and (2) that the same is true of the rule requiring the hyphen to avoid the suppositions misleading in such cases as: walking beam, living room, walking stick—but usage does require the hyphen however in every case where its use is required to make the sense clear.

In connection with this paper I may add that some 15 years ago I made a collection of upwards of 7,000 two-word combinations and found then that in the newspaper, sciences, industries, etc., there were many more two noun combinations in the two-word form than there were of those hyphened; but that in pure literature the two forms about broke even. I was as unable then as now to discover any *rule* or *principle* that would explain why some of the words were hyphened and not others which seemed the same in principle of formation. I believe that in the end the hyphen will be used only with a definite meaning, and it is plain to see how this can be done.

A GENERAL ENGINEERING COURSE.

BY C. H. BENJAMIN,

Dean, School of Engineering, Purdue University.

Letters under date of March 4 were sent to seventeen representative technical universities, asking for information as to present or prospective courses in general engineering. By this was meant a course which for the first two years should be practically the same as the other engineering courses, but which in the junior and senior years should contain a selection of subjects from other courses embracing fundamental principles rather than special applications.

The answers to these letters show only two institutions which have such a course at present. Ohio State University has a course in general engineering, the first two years being in required fundamental subjects and the last two years being almost entirely optional. Some work in commercial engineering is included. Massachusetts Institute of Technology offers a course entitled general engineering. There is a pretty definite schedule under the direction of a special committee but some electives are allowed. "This course is designed to meet the needs of those who do not wish to specialize in any particular branch of engineering to the extent demanded by the regular engineering courses."

Cornell University formerly had such a course which was very successful and was discontinued solely on account of the death of Professor Hess who was conducting it. It has been consolidated with the course in industrial engineering.

Minnesota has just abolished a course of this kind which had been in operation several years, the reason given being that it had become a refuge for "lame ducks." There is a

flourishing school of business at this university which offers some courses suitable for engineers.

The University of Michigan has certain group options covering from 12 to 17 semester hours in the senior year and among these are options called general engineering, science, including advanced work in mathematics, physics, chemistry, civil engineering, mechanical engineering, electrical engineering, astronomy, mechanics, mechanism, chemical engineering, political economy and sociology. In this option eight hours are free electives. A fifth year is contemplated and many of the technical subjects may be carried into this year, leaving the four-year course more general than at present.

Illinois is considering the development of a new training course for foreign sales engineers, which will be of a general character.

The University of Pennsylvania has the subject of a general course under consideration and the matter is now in the hands of a committee.

Several institutions have options or partial courses in industrial engineering which in some ways answer the demand for a general course.

The Pennsylvania State College has such a course leading to a degree, which includes management, organization, industrial planning and salesmanship.

Courses in economics and history are given in the junior year for all engineering students while in the senior year electives are offered in business law, corporations, transportation, money and banking and political science.

At Sheffield Scientific School the governing board is considering a course in administrative engineering which will include industrial management, labor problems, statistics, business law, etc.

The University of Pittsburgh is planning a course in general engineering which will probably be called executive engineering. This will be similar to courses in industrial engineering administered elsewhere.

Wisconsin had at one time a course in general engineering which did not prove satisfactory and which was accordingly abandoned. The course was specific the first two years but was largely elective in the junior and senior years. This tended to make it an easy mark for indifferent students. At present options are offered in economics, management, etc., to engineering students.

The State Colleges of Iowa, Kansas, Michigan and Nebraska report no movement in the direction of general engineering courses.

Rensselaer and Worcester are likewise reported as not contemplating courses of this character.

I take the liberty of quoting from one of the letters received, the opinion of a prominent professor of engineering in one of the larger institutions as the quotation seems to me to outline the situation very clearly:

"1. There was a time when specialized training in the various engineering branches was distinctly desirable, but at the present time, engineering is so far developed that a competent engineer needs a broad fundamental training in engineering. He will still be able to specialize if he desires after he has found out the particular phases of engineering which he is called upon to know in detail. Our present system of specialization along the lines of mechanical, electrical, civil, chemical and other engineering subdivisions is extremely narrow and tends to give a man a very small pedestal upon which we expect him to build a somewhat broader superstructure. In my opinion, the procedure should be exactly reversed.

"2. It is very well for a young man 19 years of age to labor under the impression that he wants to specialize along certain definite lines, but experience, of course, has shown all of us in the educational fields that this is a serious mistake, as a man of real capacity seldom follows the particular details upon which he specialized while at college. When he reaches 40 or 45 years of age and has become a man capable of assuming large responsibilities and has to associate with men of broad

education and with large business and social opportunities, he begins to realize how seriously handicapped he is through his failure to take advantage of a more general education while in college.

"3. Unfortunately, today, we turn out in the majority of our institutions, a large percentage of men who will never be engineers. They belong to the general group of mechanics or mechanicians. This will probably always be true, but it seems a mistake to restrict and narrow the educational possibilities of the men who have the natural qualifications and capacity to handle an engineering course from a broader viewpoint than that of the mechanician.

"4. Realizing that courses in general engineering as tried at some other institutions had proved to be the waste basket into which lazy, inefficient men finally landed, thus giving the course a 'black eye,' I feel that if we introduce a course in general engineering, it should be somewhat on the following basis.

"Instead of being the waste basket into which men unable to maintain themselves in the regular engineering courses were allowed to drift, the course in general engineering should be placed on a higher plane then the detailed, specialized courses. Only a limited number of students should be given the privilege of taking the course. It should be regarded as a mark of distinction to be approved for this course.

"On this basis I believe that such a course could be made a very distinct success and would meet a very definite requirement of the present day."

Summing up the information received from seventeen institutions, we find *two* which administer courses in general engineering at the present time, *three* which have had such and abandoned them for divers reasons and five which have a course of this character in contemplation.

In this last group some will probably adopt a course rather of the industrial than of the general type.

The following conclusions seem warranted by the data:

A GENERAL ENGINEERING COURSE.

(*a*) The need is felt of a certain amount of general engineering and business training outside of the usual curriculum.

(*b*) This need is to a degree met by the use of options and electives in the junior and senior years.

(*c*) When a fairly liberal course in administrative or industrial engineering is open to students, the need of the general course is not so evident.

(*d*) The failure of general courses in the past has been due to the lack of a rigid, well planned course and to the over liberal use of options.

(*e*) The subject of giving a broader training in engineering is one which is being largely considered by many of the leading technical institutions.

GEORGIA TECH SECTION.

BY R. R. KIRK,

Secretary.

Members and friends of the Georgia School of Technology Section of the S. P. E. E. were addressed recently by Mr. S. C. Coler of the Westinghouse Electric & Manufacturing Co. on "Opportunities for Technical Graduates in the Electrical Field." Mr. Coler also called attention to some of the weaknesses of the technical graduate from the employer's point of view.

America is taking her predestined place in world affairs; she is sending out increasingly her raw materials and her manufactured products; ships must be built and outfitted with improved machinery; harbors and docks must be built; the demand is to be increasingly great for men of resource and education to develop production and transportation to their utmost.

The speaker believed that teachers in technological schools should emphasize fundamentals and also the economic aspects of engineering. Specialization can be overemphasizezd. The demand is for engineers, not for C.E.'s, M.E.'s, etc.

The young engineer is often found to be lacking in the following particulars: In native ability of the engineering kind; in judgment in practical matters; in a knowledge of men that enables one to work with them, and especially with workmen; in a comprehension of the position occupied by the engineer in industrial society; in the ability to measure values; in observation; in originality; in the sort of courage which enables one to accept responsibility; in a knowledge of business ethics; in a proper conception of the importance of health as a factor in success.

These were presented as matters for teachers of engineers to consider. Some of them, it was believed, might be to some degree corrected by the teacher; others are perhaps beyond his control. But the teacher's aim should be to prepare his students to take part in a work calling more and more insistently for originality, resource, breadth of view, and a genuinely scientific knowledge of fundamentals.

METHODS OF PREPARING REPORTS FOR TESTS IN ENGINEERING LABORATORIES.

BY H. H. FIKRER,
Assistant in Mechanical Engineering, University of Illinois.

One of the most important and to a great extent puzzling problems, with which those of us who are selected to guide the destinies of an engineering laboratory, is the matter of deciding upon a correct method of reporting a test. If the writer is to judge by his experience and his association with the laboratory staffs of some four or five of our state universities, it can be safely said that at the beginning of each college year the main question to be discussed at the first staff meeting, is the one concerning report writing. Needless to say that a great many systems have been adopted and pursued for a year or two and then abolished for the reason that the personnel of the staff has changed and consequently the method of the "older fellows" must be done away with. Thus it is seen that it is greatly a matter of opinion.

It is worth while to review briefly the outlines of some arrangements used in certain laboratories from time to time, and discuss the merits and shortcomings of each.

Remembering that the students are to be taught the proper method of complying a report of a commercial test, the following form may be considered.

The report should be headed with some conventional form of introduction as given below:

To the Experimental Eng. Lab.,
Dept. of Mech. Eng., XYZ/, A
The University of XYZ. Sept. 1, 1917.

Gentlemen:

I would respectfully submit the following report on ————
(State here the title of the experiment)

1. *Object:* State clearly and concisely the object of the experiment, and give the date on which the work was done.

2. *Apparatus* (*a*) Apparatus tested. Describe in a genral way the apparatus tested, making use of sufficient diagrams, photographs, blue prints, or sketches to make clear the arrangement of the apparatus. Where diagrams, etc., are used, give each a title, letter its parts, and refer to those parts by letter. All diagrams aid sketches should be in ink, not pencil.

3. *Method:* Describe the method of performing the experiment or test, in making the test, describing any special forms. Where it seems desirable, make use of photographs, diagrams, sketches, etc., as above.

3. *Method:* Describe the method of performing the experiment or test, telling exactly what was done in carrying on the work.

4. *Data:* Tabulate all data (this refers especially to observed data) in neat form in ruled columns on a separate sheet or sheets. Provide a proper explanatory title to each table, and head each column with name of observation and the unit in which it was measured.

When indicator cards are taken, always include sample cards, firmly and neatly attached to a standard-size sheet, giving on each card enough data to identify it completely.

5. *Results:* Under this head should be included:

(*a*) Formulæ used, explaining how they are derived.

(*b*) Sufficient computations with all operations indicated, so that the method of obtaining all results may readily be understood.

(*c*) Final results in tabular form.

(*d*) Curves where desirable, showing graphically the results obtained. These should be plotted on 8½ x 11 coördinate paper, punched on the left-hand side. Each sheet should be labeled, unless otherwise directed, take the dependent variable as ordinate, and as a rule place the zero of the curve on the curve sheet. Print the legend for the abscissa horizontally and that for the ordinate vertically, so that each reads away from the orgin. Always state the unit in these legends. Plot the curve to a reasonable scale, indicating the observed (or calculated) points by means of small circles, squares, etc. Usually a smooth curve does not have to go through all the points.

6. *Discussion:* Give a brief summary of the experiment, calling attention to the most important results obtained. Discuss any peculiarity of the results themselves; if too high or to low, discuss possible causes. Discuss anything tending to prove or disprove doubtful data. State what your results prove. If any laws are developed, state them. Compare with theory and standard practice and state whether or not the machine or equipment tested has fulfilled special requirements. In every case where quotations are used, the name of the authority quoted, and the reference, should be given. Respectfully submitted,

(Signature).

The above form is no doubt one that if carefully and completely followed out by the student will result in a satisfactory report. The most important element, however, which plays a large part in adopting a form such as the one under consideration, is time. If the student is to write such a report on every test that is run during the entire semester, will he be devoting such a large portion of his time to his laboratory course that he must necessarily let some other course "slide?" This has been the case at times. In order to take care of this point the above long and complete form could be tested to only a few of the tests made, say 2 or 3 during the semester. In that case it would be best to require this long form to be applied to one of the first tests in the course, then one about the middle and one towards the end of the semester, in order that the student may profit by the corrections made to the previous report. Another way to require less outside time from the student in preparing such a report is to allow him a number of laboratory periods after the period in which the test was run, to compute the results, plot curves, make sketches and diagrams, leaving only the descriptions of the apparatus, method of procedure and discussion of results to be written during study hours outside of the laboratory.

It is interesting to notice the conventional form of introduction used in the above outline. While some such beginning would be essential in commercial reports, the opinion of the writer is that a letter would accompany the report when it is submitted and contain this section more properly.

Under the title of Apparatus it will be seen that photographs are made use of. While photographs of the unit tested equipped with the testing apparatus provides a very convenient means of showing the set up of the test, it is very doubtful whether the student profits to any large extent from examining the photographs, marking the various parts with different letters and tabulating the names of these parts corresponding to the letters placed on the picture. Opinions differ on this point very greatly, and the writer begs to discuss this part of

the report by merely submitting his personal opinion. Experience has shown that requiring the student to draw a line diagram of the unit or units tested showing pipe lines, belting and similiar attachments, while requiring a considerable amount of time, is liable to be of greater service in giving the student a better knowledge of the equipment he tested than a photograph would. To save time, a cut of the line diagram of the apparatus tested can be supplied to the student, which would appear in the final report. In a number of laboratories neither a photograph or a line diagram is used. In deciding the necessity of using some kind of a cut of the apparatus tested, it should be remembered that the function of laboratory instructors is not merely to have the students take readings of pages, thermometers, speed counters, and the like and then proceed to the computing room and make his calculations. This only constitutes a small part of the work, for the student usually is taught in some previous theoretical course how to make these computations. A great deal of attention should be given to the methods of taking readings, the function of each measuring device used, the way in which that device is connected and its point of location, so that the student may learn just as much on the laboratory floor as he does in the classroom. One of the main weaknesses of our present laboratory systems is that everything is made ready for the student, so that he never gets any experience in preparing a machine for a test, nor is it impressed upon him that making preliminary tests are absolutely essentials. In fact in many cases the student is not acquainted with the method of starting and stopping the machine he is testing. Is it any wonder then that some of our graduates would be completely at sea if he were to be obliged to organize a test and make a report of his work? It must be admitted that to cover the various types of machines in a certain line, a large number of tests must be made during the time allotted to laboratory practice, but no doubt it would be more advisable and essential that to make fewer tests and spend enough time on each test for the student to

receive a complete understanding of the test methods employed, and the general purpose of the test, rather than have a large number of tests and devote a very small amount of time to essential fundamentals. The modern trend in the revised engineering courses is not to devote a great deal of time to specialization, but to give the student a good, solid, general fundamental course in engineering upon which he may build after he finds his choice for specialization when he has had more of the particular kind of experience necessary in that field. It seems that some such reasoning may well be applied to laboratory practice, for one who is familiar with methods of testing, and who has been taught to cultivate accuracy and neatness in work, is much more liable to make a success as an experimentor than one who has specialized in testing a certain line of machinery, or one who has had in his training been allowed to make tests of a large variety of machines, but has little knowledge of fundamentals.

The third part of the outline is no doubt essential whether a mere laboratory or a commercial report. Methods used in conducting the test must be explained if one is to be able to account for certain points in the results which may not be self-explanatory.

Passing on to the fourth part, we come to a very important point. The matter of teaching students how to take neat and accurate readings is by no means an easy one. The observed data or the data taken on the test should be kept on sheets as specified in the form under consideration. One of the best methods of taking the readings is to provide a general log sheet, on which should appear neatly tabulated all the readings taken during the test. In case a complete report is to be made of the test, a tracing and blue print can easily be made of this log sheet and each student on the test be provided with a copy. Furthermore having all the data on one sheet, where it can be totaled and averaged, diminishes the chances for one or a few of the various station logs sheets to get lost and therefore make the whole test useless. Without further dis-

cussing the above form, it is worth while to consider very briefly the following outline:

"*Section 1.* This includes:

(*a*) Object of the test.

(*b*) Performance guarantees which the equipment is supposed to meet.

(*c*) Summarize the most important test results, and state your conclusions concerning same.

"*Section 2.* This includes:

(*a*) Curves or graphical log sheets.

(*b*) Data and results sheets.

"*Section 3.* This includes:

(*a*) Description of test including the apparatus as tested and the methods employed in testing, also sketches and diagrams.

(*b*) A brief discussion of any special methods used or unusual conditions existing during test.

"*Section 4.* This includes:

(*a*) Sample calculations.

(*b*) Indicator cards."

It will be seen that this outline is similar to the one previously presented, containing almost the same items and differing only in the matter of arrangement.

The writer would recommend this arrangement as in his opinion it represents more nearly a commercial type of report if complied in the order shown. Attention could be called to Section I. part (*b*) and part (*c*), which did not appear in the first outline considered. The advisability of stating the guarantee which the equipment is to come up to goes without saying. One who is in the position of buyer, no doubt ought to be informed of the guarantee under which the particular piece of equipment is to be sold.

Part (*c*) is more or less an answer to part (*b*). This section should not contain any more results than what is included in guarantee. If part (*c*) contains the proper results and a precise conclusion includes a recommendation concern-

ing the equipment, the rest of the report may in many cases become a minor part.

Section 2 in two parts contains what is no doubt the next important section of a commercial report. If one is not convinced by the contents of section 1 and has a desire to further investigate; parts *a* and *b* of section 2 will no doubt give valuable information and show the performance of the machine, tested.

Sections 3 and 4 are contained in the form previously discussed. The only difference is the order in which they appear. Section 3 is essential as far as a complete report is concerned, but could be omitted from a commercial report but must be included in a report made by students if the instructor is to be able to trace out an error.

Part (*b*) of Section 4 of course should be included in either case.

The above discussion does by no means exhaust the subject and solve the problem. Conditions, such as the number of hours devoted to laboratory work, the equipment available for testing, and the theoretical courses a student takes in his curriculum has a great deal of effect. With the amount of time usually available for laboratory work the student can not be taught correct English. It would be advisable to have a course some where in the students' schedule when he can be taught to compile a commercial report. This course for engineering students, should deal with engineering subjects and preferably should be taught by one who has made a study of writing engineering reports.

The courses taught in the class room when the theory is expounded upon the apparatus the student is to test when he enrolls in the laboratory course, should so correlate with the laboratory course that time ought not to be spent in the laboratory in repeating the theory. The matter of corrolation is important and it is safe to say that one can easily find a good deal of repetition in courses at the present time.

PRELIMINARY REPORT OF THE COMMITTEE NO. 11–A, PHYSICS.

The work of the Committee of Physics has reached a stage where a review of its endeavors should be given and a recommendation made to the Society for future action. The present Committee was appointed in 1916. It found that its predecessor had presented an excellent report which contained the results of a survey of the courses in physics in the various engineering colleges and certain important recommendations. Your Committee proceeded to ascertain in what direction the greatest assistance could be rendered to instruction in physics and it decided that correlation of the course in physics with subsequent courses using the fundamental principles of physics would be the most valuable contribution the committee could make in the work of the Society.

On March 15, 1917, the Committee on Mechanics, through its chairman, Professor E. R. Maurer, agreed to a joint effort in coöperation which may be described as the "preparation of a syllabus on mechanics" as a highly "desirable method of influencing the coöperation which should exist between the two courses in mechanics." The Committee on Physics was to prepare the physics portion of the syllabus and the Committee on Mechanics was to prepare the material for the course in mechanics. The order of presentation of the topics of the syllabus was to be merely that of convenience, emphasis being placed on subject matter rather than upon order of presentation.

The Committee on Physics prepared its portion of the syllabus which was submitted to the Committee on Mechanics on December 6, 1917. The form of the "Content" was an alphabetical list of subject matter, with all formulæ, units and even the nature of the problems, the latter appearing each one in

its appropriate place. Suitable cross references were made, so that it was possible to ascertain quickly just what was supposed to be taught in the first general course in physics on the subject of mechanics. The effort of the Committee was to be brief, to be concrete and specific, to avoid "methods of presentation" and the arguments resulting therefrom and to furnish a clear picture of what should be expected of the first course in physics. In the relatively brief time between December, 1917, and June, 1918, no report was made by the Committee on Mechanics to the Committee on Physics as to the progress of the proposed syllabus.

On December 19, 1918, the Committee on Physics resubmitted the "Content" to the new Committee on Mechanics and Hydraulics, recently appointed. The latter Comittee considered the original proposal and reported back to the Committee on Physics on May 19, 1919, that the Committee on Mechanics and Hydraulics seemed to be in favor of cooperation. No further report was had from this Committee until the chairman of the Committee on Physics requested a conference with the Chairman of the other Committee. Then the latter consulted with a member of his Committee and several others and formulated a tentative report indicating that the coöperation as proposed was inappropriate. But later, on May 3 and 4, the chairman of the two committees had an extended conference which very naturally brought about a better understanding as to what the Committee on Physics hoped to accomplish by its plan of coöperative effort. The chairman of the Committee on Mechanics and Hydraulics, Professor O. H. Basquin, was not convinced that the exact plan proposed by the Committee on Physics was the best to be had. No future plans were laid as to a joint action of the two committees because of the short time remaining before the annual meeting.

The Committee on Physics wishes to present to the Society briefly its defense of the plan of coöperation described and the possibilities of correlation arising from its application. The

basis of the argument presented briefly, and hence inadequately, is as follows:

1. All efforts at coöperation must have as a basis relevant facts; this is the starting point of all endeavor in which the scientific method is used.

2. The most important information that should be available as a basis of coöperation in and consequent correlation of the two courses of mechanics, is the *content* of the two courses.

3. Such information should be in reference form. This could be accomplished by the completion of the alphabetical topic list described above, the "content" of the mechanics course being placed perhaps in a parallel column with the content in the physics course. This would make the information desired available with a minimum expenditure of time.

4. From such information immediately would arise definite possibilities of correlation as illustrated by the following attainments:

(*a*) The securing of more appropriate emphasis in the physics course.

(*b*) The saving of time and improvement of results in the mechanics course through the utilization of review as such. Other possibilities will occur at once to a teacher in either course.

The chief arguments against the form of coöperative effort proposed are as follows:

1. Instructors in mechanics and physics are fairly well satisfied with conditions as they are. The reply is that it is not the satisfaction of the instructor in which the Committee should be interested, but the fact that the student takes two succeeding courses in the same subject between which no effort at correlation has been made by the Society.

2. Coöperation can be had in any institution where the instructors desire it and such a plan as proposed is not necessary. The answer is that the Committees' work is that of the Society, that, truly, the Society is not necessary, but that each

Committee should endeavor to make the Society as effective as possible in improving engineering education.

3. Instead of the proposed plan it may be better to formulate a general plan and let each institution carry it out as suits individual preference. The answer is that the Committee on Physics does not favor advice, but rather a constructive piece of work of a concrete character, believing that this is a kind of a contribution that the Society should make.

In this connection, your Committee calls attention to the fact that at the Virginia meeting in 1916, it was moved by Professor Greene, seconded and carried, that "It is the sense of this meeting that the Committee on Mechanics in the preparation of its syllabus hold conferences either by letter or at meetings with the Committee on the Teaching of Physics."

A further word in reference to correlation might make clearer its meaning and its need. Correlation between courses articulates instruction by eliminating gaps and inconsistencies between them. It makes the work more interesting to the student and it tends to economy in his time. It enables an instructor to do better work; it gives him definite information regarding the previous intellectual attainments of his students, and it shows him what they will be called upon to do in future courses. He is able, therefore, to give them instruction that is adapted to their preparation, and to the demands of other instructors. He is able to review old material as such and thus greatly aid its retention by the student.

Moreover, the instructors in any one department develop departmental ideals and traditions, and methods of teaching and establish the ground covered largely independent of other departments; they feel pride in their own department; they concentrate upon their own work; they think they have not time to understand the points of view of other departments. A feeling of mutual distrust naturally arises and some degree of isolation ensues; isolation is the opposite of correlation.

Your Committee wishes to express the opinion, based upon the thought given the matter and upon its experience in

working with another Committee, that the correlation of the course in physics with subsequent courses in which the fundamentals of physics are used is highly important; that the Society should appoint a Special Committee for the purpose of making a report upon the subject; that this report should describe the desired correlation in mechanics in such a manner that the report can be applied directly without requiring each institution to work out, ab initio, its own plan, that the report should be concrete in at least one subject, mechanics, and that it include a statement of the practicable ways and means of securing correlation in other subjects as well.

Your Committee therefore recommends that the Society authorize the appointment of a Special Committee whose duty shall be to make a report upon the correlation of the course in physics with subsequent engineering courses, particularly that in mechanics.

PRELIMINARY REPORT OF COMMITTEE NO. 12, ENGLISH.

The following communication was sent to deans and heads of English departments in the various engineering colleges represented in the S. P. E. E. membership. As will be noted from the topics given, the object of this particular inquiry was to learn the policy of the several institutions with regard to English literature and to other non-technical subjects more or less closely related to the work of the English department. Topic No. 6 belongs to a separate investigation, on which a special report will be made at the 1920 session of the Society.

TO THE DEAN OR THE HEAD OF THE DEPARTMENT OF ENGLISH IN THE ENGINEERING COLLEGE.

The Committee on English of the Society for the promotion of Engineering Education wishes to ascertain as fully as possible the present status of what may be called "liberal" studies, and particularly those which are directly in charge of the English Departments in the various Engineering Colleges. Although part of this information is found in the college catalogues, it is desirable that the brief official announcements

be supplemented with statements of policy and procedure. To this end, the Committee would like to have not only statistical data but also comment from those who are responsible for the curriculum. The suggestions given below should therefore be regarded as an invitation to discuss these and other phases of the subject, and not as a questionnaire to be answered briefly and categorically. The Committee will be glad to have replies reach the Chairman if possible before May 10, 1920. Supplemental answers after that date, however, will be acceptable.

1. Amount of time given to literature and literary composition in the course in engineering.

2. Recent changes of policy, if any, affecting the amount or character of instruction in humanistic subjects. (Include History, Political Science, etc.)

3. Most successful methods which have been found for presenting the "liberal" or broadening subjects to engineering students.

4. Attitude of students toward such instruction.

5. Attitude of instructors in Technical Departments.

6. Qualifications sought in a teacher of English for Engineering students.

COMMITTEE NO. 12,
C. W. PARK, *Chairman*,
University of Cincinnati,
FRANK AYDELOTTE,
Massachusetts Institute of Technology,
SADA HARBARGER,
Ohio State University,
J. R. NELSON,
University of Michigan.

SYMPOSIUM ON "LIBERAL" STUDIES FOR ENGINEERING STUDENTS.

Statistical matter will be included in the later report, but for this brief preliminary statement, it seems advisable to cite only general expressions of attitude and policy. In order to stimulate discussion, a symposium of typical comments compiled from the answers is here presented:

Parallel with the course in English during the Freshman Year runs a course in the History of Civilization. In the Sophomore Year Political Science and History of Recent Times are parallel courses to the English course. In this way we have successfully introduced certain "liberal"

subjects into the engineering curriculum. Following these courses, the thread of liberal subjects is maintained during the Junior and Senior years by couses in Economics, Logic, and Psychology. The method found most advantageous is the lecture. It is a relief to engineering students from their mathematical, physical, and shop studies, to attend once or twice a week a good lecture on some liberal, broadening subject.

The instructors in charge of these courses do not hesitate to introduce outside matters into the courses when some topic appears to be of value to the students.

The attitude of the students towards such instruction is very good. The upper-classmen are especially fond of these two lecture hours per week. The instructors in all the technical departments are also very sympathetic towards these courses. Upon the whole, they have proven very attractive both to students and faculty and they have had a marked success in our institution.

DEAN MORRISON,
Armour Institute of Technology.

The most successful methods for presenting "liberal" subjects to students in the Engineering School have been found not to differ, in any essential respect, from those adopted in dealing with students in the College of Arts.

Students in engineering are responsive to liberal studies and their work compares favorably with that done by students fom other schools. It is not true, as sometimes stated, that undergraduates in technical schools are hostile to humanistic subjects.

The spread, among the most influential members of the profession, of enlightened views with respect to the function of the engineer as a responsible member of society is wholly favorable to the promotion of liberal studies in technical schools and is already having its effect on the attitude of both instructors and student body. It is perhaps needless to point out that the movement will probably prove retroactive and that, by the infusion of broader ideas, the teaching of technical science itself will ultimately be informed with a more liberal spirit than has characterized it hitherto.

PROFESSOR DANIEL E. OWEN,
Department of English, Towne Scientific School, University of Pennsylvania.

We should like to increase the amount of time given to this subject and we hope to be able to do so in the near future. The difficulty in the way is the crowded condition of the time-table, rendering it hard to find additional time without unduly burdening the student. We have recently

extended our course on Economics in the Faculty, and have included in it certain subjects which are sometimes classed under the head of Political Science.

It is somewhat difficult to convince the students of the necessity of the study of the English language, since they are apt to feel that purely technical subjects are more important. I think, of recent years, however, by clearly putting the facts of the case before them, that students have been won to a more general appreciation of the importance to them of possessing a good knowledge of their own language and of acquiring the ability to use it.

FRANK D. ADAMS, *Acting Principal*,
McGill University.

The attitude of the instructors in technical departments toward English and Economics is altogether friendly. Every one realizes the importance of the subject. There are some differences of opinion as to how they should be taught, but every one believes in them as a necessary part of the engineer's training.

DEAN RAYMOND,
Iowa State University.

I understand by "humanistic elements" those elements in the course which would tend to broaden the student's general knowledge and to interest him in subjects outside his immediate technical fields. In the first place, throughout the course in Freshman English every effort is made to induce the students to do general reading, as we call it, in a rather large selected library of first-rate books. In general, students are encouraged to choose their reading as suits their inclination from this highly selected library. We do, however, attempt to induce the student to read in different fields and in different types of literature, so that by the end of the year he will have had a taste of various kinds of writing and some initiation in different fields of thought. This reading of which I speak is included under what is generally called "collateral reading." Within the course itself the liberal elements are less represented in the first semester than in the second, since our effort in the first semester is necessarily directed toward overcoming the student's elementary faults in composition. Still even in the first semester a considerable amount of good selected expository reading is associated more or less closely with the class work. It is in the second semester, however, that the liberal elements in the course are chiefly represented. The course in the second semester consists, on the one hand, of a regular scheme of theme writing, one theme weekly, and on the other hand, in the accompanying reading of a limited amount of classical English prose. In the current semester

this prose consists of the first chapter of Matthew Arnold's "Culture and Anarchy," Emerson's "Self-Reliance," an essay of Ruskin's and an essay of Stevenson's. This limited amount of reading is read in the classroom with uncommon minuteness and much opportunity is given for the discussion of ideas which may arise. Through this means students are bound to come into contact with a considerable variety of important ideas, ideas which not infrequently are made the subject matter of their own compositions. I should add perhaps that we are extremely prudent in making use of his subject matter for work in composition, since we insist on the student making direct application to his own experience of the ideas which he presents.

PROFESSOR FREDERICK A. MANCHESTER,
Department of English, University of Wisconsin.

The principal change in the administration of English is the examining of Freshman students on entrance and the placing of those deficient in English in a separate class. As a rule, these deficient students would be debarred from foreign language and would be required to take additional work in English. There is a decided tendency at present toward giving more opportunity to students in the Junior and Senior years for the study of the so-called humanities and to offer courses in technical English, and Industrial Economics which shall apeal to engineering students; these latter, however, to be mainly elective.

It seems to me success in teaching these subjects to engineers depends on making them more applicable to their particular work and giving practical applications in connection with the course. The student will much more readily take technical or journalistic English than a course in English poetry and prose.

The attitude of the student is not hostile but rather inclined to be utilitarian. He usually lacks interest in a subject whose application he can not foresee.

The general attitude of instructors in technical departments is favorable to broadening of the engineering course, as they realize from their own experience the deficiencies which handicap the engineer at present.

DEAN BENJAMIN,
Purdue University.

I have noted no especially successful method for presenting "liberal" or broadening subjects to engineering students. As a matter of tactics, rather than method, I believe in presenting the opportunity for such work to engineering students in their Junior and Senior years rather than earlier. The opportunity is then much more likely to attract them.

Upper classmen in engineering are, to a very large extent, willing and even desirous of studying other than technical subjects, if the opportunity

for such study can be found. First- and second-year men are generally either indifferent or disposed to avoid as much as possible contact with other than engineering subjects.

Instructors in the technical departments are, in general, favorable to broadening the engineering curricula if possible but have come to the conclusion that a four-year course offers little opportunity for such broadening except at the expense of essential technical subjects.

DEAN STOUT,
University of Nebraska.

Recent changes in policy include:

(*a*) The increase of required work in English. I believe the amount of such work as shown in (1) is unusually large, being about ten per cent. of the total work required for graduation.

(*b*) The introduction of a required course in Citizenship, 3 hours a week, for one term, in the Junior ear.

(*c*) The introduction of an elective course in Modern European History, 3 hours a week for one term, in the Junior year.

Informal lectures, assigned reading and written discussions.

Students are inclined at first to minimize the value of the liberal studies, but later on show considerable appreciation.

DEAN PURYEAR,
Texas A. and M. College.

A majority of the older men on the faculty of the College of Engineering desire that our students take up seriously work in English, philosophy, economics, psychology, sociology, etc. I know that many of us urge them to give some consideration to questions not regularly incorporated in the engineering curricula, but which are of interest to well-educated men.

DEAN RICHARDS,
University of Illinois.

Question No. 3: Since these subjects belong to the College of Arts and Science primarily and very few engineering students take them in proportion to the total enrollment in such courses, the methods of presenting these subjects have usually been as customary for Arts and Science students with little attempt to adapt them especially to the needs of technical students. This will not be true of the new course, Introduction to Economics, which is designed especially for engineers.

The attitude of instructors in technical departments: Most of our engineering instructors are glad to have the students elect the above types of courses, but there has been little disposition to attempt to cut down

the requirements in technical courses to make room for the more liberal electives.

ACTING DEAN BOAREMAN,
University of Nevada.

Most successful methods which have been found for presenting the "liberal" or broadening subjects to engineering students: The most successful methods which have been found are the employment of really first-class professors to give the workmen who know what they are teaching and have personality which will inspire the students. In addition we conduct what might be described as almost a propaganda to influence students to enter these lines of work.

Attitude of students toward such instruction: The attitude of the students generally reflects the ability with which the work is presented. There seems to be increasing interest of engineering students in broader and more liberal training. Left to themselves, engineering students are slow to see the merit of non-technical work.

DEAN MARSTON,
Iowa State College.

There is a wide variety of opinion as to the best methods of presenting the so-called liberal subjects to engineering students, but there is unanimous agreement on one point and that the first essential is a sympathetic attitude on the part of the teacher toward the aspirations of the student, whatever they may be. If they are not of the highest type, this sympathetic view point is absolutely necessary to enable the teacher to lead the student into some other and better state of mind.

DEAN MCCAUSTLAND,
University of Missouri.

Besides the liberal studies as indicated above, we are encouraging our engineering students to take additional work in English, history, civics, and journalism. The records in my office show that at least three-fourths of the engineering students who have graduated during the past four years took one or more additional courses in the above liberal studies. Our engineering students are particularly interested in adding to their assignments such subjects as business English, advertising, oral English, money, and banking, sociology, technical journalism, and Spanish. Our students seem to show a splendid attitude particularly during their junior and senior years towards the so-called liberal studies, and we have little difficulty in convincing them of the importance of adding as many such subjects as possible to the required subjects in their curriculum.

DEAN POTTER,
Kansas State Agricultural College.

COMMITTEE NO. 22, INTELLIGENCE TESTS.

The tendency recently has been to introduce as much elective work in humanistic studies as is possible in the rather rigid confines of the engineering courses. On page 28 of the current catalog you will see that economics is required of the juniors in the C.E. course and that six hours of electives are open to seniors, three being required. Formerly very little choice had been given here.

After many years of experimenting I have found that the most successful method of presenting literature and advanced English reading is to get the message home and to treat technique only incidentally. I never lose sight of the fact that the men are training to be engineers but I also assume that they have certain definite human and social interests through which literature can be made to appeal to them.

PROFESSOR JAMES W. TUPPER,
Department of English, Lafayette College.

With grateful acknowledgment of the coöperation of the men whose remarks are quoted above, and of others whose contributions will be noted in the later report. The Committee submits the foregoing preliminary statement.

C. W. PARK, Chairman.

COMMITTEE NO. 22, INTELLIGENCE TESTS.

The report of Committee No. 22 on Mental Tests for engineering freshmen, which will be presented at the June Convention of the Society, will not be ready in time for the May issue of the BULLETIN. However, the report will be similar to that which has already been prepared for the engineering freshmen at Carnegie Institute of Technology. This local report is therefore submitted for the May BULLETIN as a sample of the type of analysis for which the data from all the forty-eight participating colleges is now being studied. The convention report will be a summary of the various local reports.

REPORTS OF MENTAL TESTS IN THE DIVISION OF ENGINEERING AT CARNEGIE INSTITUTE OF TECHNOLOGY, PITTSBURGH, PA.

Freshmen, Autumn Quarter, 1919.

This report concerns the findings in the six tests that were given the engineering freshmen under the auspices of the Society for the Promotion of Engineering Education. It has special reference to the standing in the tests of those students who have dropped out from college for various reasons during the first quarter. It is therefore only a preliminary report. The complete records of withdrawal for the first year will be evaluated next summer. The scholarship records for the first quarter will be evaluated in terms of points for quality and the relationship between points for quality and the test scores will be compared as soon as the quality points are available.

We are here interested in knowing particularly the test scores of the students who dropped out for poor scholarship, those who were transferred, and those who withdrew for other reasons.

The results are listed for each of the six tests separately and also for the six tests combined. The interpretation of the table is as follows:

Test I (Arithmetic Problems) was given to 473 students. After scoring these test papers the class was arranged into four quarters according to this test. This divides the class into four equal quarters with 118 students in each quarter as indicated in the table. Note that of the 44 students dropped for poor scholarship during the autumn quarter 25 of them are found in the lowest quarter, 10 in the third quarter and only 4 in the highest quarter. These figures are found in the second column.

The third column shows the distribution of the students transferred to the Industries School. Of the 16 students so

transferred, 12 were in the lowest quarter of the Arithmetic Problems Test and 3 were in the highest quarter.

Of the 37 students who were withdrawn for reasons other than scholarship, 18 were in the lowest quarter according to the Arithmetic Test while only 3 were in the highest quarter. These facts are found in column 4.

TABLE I.

	1. Total in Each Quarter of the Class.	2. Dropped for Poor Scholarship.	3. Transferred to Other Departments.	4. Withdrawn for Other Reasons.	5. Probability of Remaining in Good Standing at End of Three Months.	6. Total Withdrawn.
TEST I, ARITEMETIC:						
Highest quarter	118	4	3	3	91	10
Second quarter	118	5	0	8	89	13
Third quarter	118	10	1	8	84	19
Lowest quarter	118	25	12	18	53	55
TEST II, ALGEBRA:						
Highest quarter	118	4	4	8	87	16
Second quarter	118	3	1	4	93	8
Third quarter	118	24	1	6	74	31
Lowest quarter	118	13	10	18	65	41
TEST III, GEOMETRICAL CONSTRUCTION:						
Highest quarter	116	2	0	4	95	6
Second quarter	116	4	4	4	90	12
Third quarter	116	13	5	11	75	29
Lowest quarter	116	23	7	12	64	42
TEST IV, INTELLIGENCE:						
Highest quarter	118	5	3	5	89	13
Second quarter	118	5	0	7	90	12
Third quarter	118	15	6	12	72	33
Lowest quarter	118	19	7	13	66	39

In column 5 we have the probability of remaining in good standing at the end of the autumn quarter. This is simply the ratio of the number of students in good standing to the total number of students. This ratio has been calculated separately for each of the four quarters of the class. Thus, the probability of remaining in good standing is 53 per cent.

for the lowest quarter and 91 per cent. for the highest quarter. *This means that if a student is in the lowest quarter of Test I, Arithmetic Problems, his chances are 53 out of 100 of remaining in good standing at the end of the autumn quarter. On the other hand, if a student is in the highest quarter of his class in Test I, Arithmetic Problems, his chance of remaining in good standing at the end of the autumn quarter is 91 per cent.*

TABLE II.

	1. Total in Each Quarter of the Class	2. Dropped for Poor Scholarship.	3. Transferred to Other Deparments.	4. Withdrawn for Other Reasons.	5. Probability of Remaining in Good Standing at the End of Three Months.	6. Total Withdrawn.
TEST V, PHYSICS:						
Highest Quarter	118	5	0	6	91	11
Second Quarter	118	10	0	6	87	16
Third Quarter	118	8	5	10	81	23
Lowest Quarter	118	21	10	14	62	45
TEST VI, GENERAL TECHNICAL INFORMATION:						
Highest Quarter	118	5	0	8	89	13
Second Quarter	118	11	2	2	87	15
Third Quarter	118	10	4	7	82	21
Lowest Quarter	118	17	9	19	62	45
RANK ACCORDING TO MID PERCENTILE OF ALL SIX TESTS.						
Highest Quarter	116	2	1	5	93	8
Second Quarter	116	5	0	7	89	12
Third Quarter	116	13	3	5	81	21
Lowest Quarter	116	24	11	19	53	54

In column 6 we have the total number of students withdrawn for various reasons and their frequency of occurrence in the four quarters of the Arithmetic Test. *There are five times as many students withdrawn out of the 118 in the lowest quarter according to the Arithmetic Test as in the same num-*

ber of students in the highest quarter according to the Arithmetic Test.

There are six times as many students dropped for poor scholarship in the lowest quarter of the Arithmetic Test I as in the highest quarter of the same test.

The same type of analysis is carried out for each of the six tests. *Thus in Test II, Algebra,* we have 13 students dropped for poor scholarship from the lowest quarter of this test whereas only 4 were dropped for poor scholarship in the highest quarter of the Algebra, Test II.

Test III, Geometrical Construction, is one of the best tests in the series. If we divide the class into four equal groups based on the score in Test III, Geometrical Construction, we find that *23 students were dropped for poor scholarship out of the lowest quarter in the Geometry Test whereas only 2 were dropped from the highest quarter.* There are 10 or 12 times as many students dropped for poor scholarship from the lowest quarter of this test as from the highest quarter. These facts are shown in column 2 for Test III.

In column 6 for Test III we find that 42 students in the lowest quarter of Test III withdrew for various reasons whereas only 6 students from the highest quarter withdrew.

From column 5 for Test III we find that if a student ranks in the highest quarter of his class in the Geometrical Construction Test the chances are only one in 20 that he will withdraw for any reason during the first three months. But, if the student ranks in the lowest quarter of his class his chances are 13/20 that he will withdraw during the first three months.

If we arrange all the scores in the *Intelligence Test IV* in order from the highest to the lowest for the freshman class and then divide the class into four equal parts we find that 19 students were dropped for poor scholarship in the lowest quarter and only 5 from the highest quarter. In other words 4 times as many students are dropped for poor scholarship in the lowest quarter according to the Intelligence Test IV as

are dropped from the highest quarter according to the same test.

Column 6 of Test IV shows that 39 students who ranked in the lowest quarter in the Intelligence Test withdrew for various reasons whereas only 13 from the highest quarter withdrew.

Test V, Physics, shows practically the same relation. Here we find that there are four times as many students dropped for poor scholarship from the lowest quarter in the Physics Test as are dropped for poor scholarship from the highest quarter of this test. See column 2, Test V. The total number of students withdrawn for various reasons from the lowest quarter of Test V is 45 whereas only 11 students from the highest quarter of the Physics Test withdrew during the first three months.

Test VI, Technical Information Test, shows again the same general relation. Seventeen students in the lowest quarter according to the General Technical Information Test were dropped for poor scholarship whereas there were only 5 from the highest quarter of this test who were dropped for poor scholarship. The other parts of the table are self-explanatory.

I wish to call your attention especially to the last table summarizing the results according to the mid percentiles of all tests. The mid percentile is the combined rank given to each student and is based on all six of these tests. The whole class is divided into four equal groups on the basis of all these tests. Inspection of this table shows that of the 44 *students who were dropped for poor scholarship and for whom we have complete records in all six tests, 24 were in the lowest quarter of the class according to the average of the six tests. Only 2 students were in the highest quarter according to the same criterion.* Eleven students from the lowest quarter were transferred to other departments whereas only 1 student from the highest quarter was transferred. Among the students withdrawn for reasons other than scholarship 19 were in the lowest quarter, whereas only 5 were in the highest quarter.

If we divide the class into quarters on the basis of the average on all these six tests there are 6 times as many students withdrawn for various reasons from the lowest quarter in the tests as in the highest quarter of the tests. The frequencies are respectively 54 and 8.

While this report is based only on the first three months of the year the results are so insistent and uniform with all of the tests and with the several criteria that there is little doubt about the diagnostic value of these tests as criteria for admission.

A similar analysis is being made for each of the forty-eight participating engineering colleges and a summary of these reports will be presented at the June meeting of the Society.

L. L. THURSTON, *Chairman.*

DEPT. OF PSYCHOLOGY,
CARNEGIE INSTITUTE OF TECHNOLOGY,
PITTSBURGH, PENNNA.

EDITORIALS.

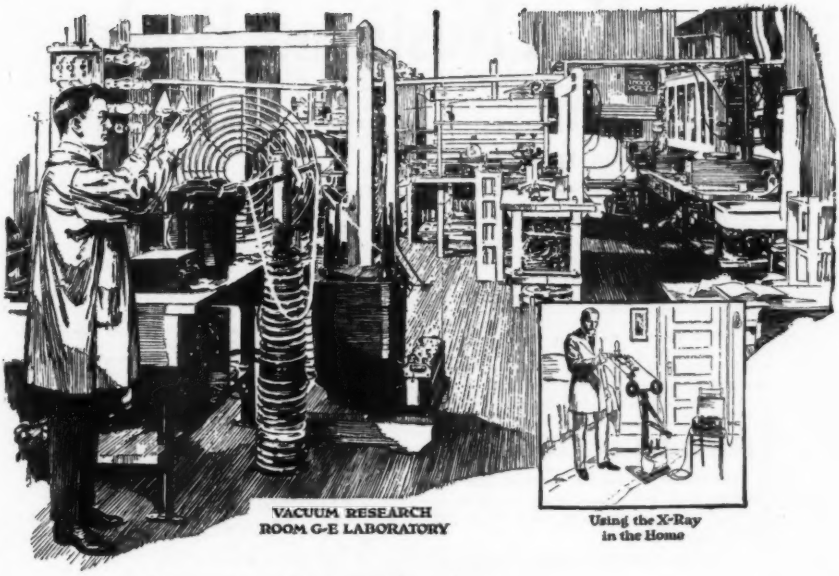
Spirit of Coöperation.—Coöperation is essentially an engineering term since only by coöperation can engineers accomplish results. Engineering teachers are using this means more than ever. The keynote of the forthcoming meeting of this Society is Coöperation. There is to be held in Washington shortly, a conference of a large number of national and local engineering societies, where an attempt will be made to coordinate these societies so that they may coöperate with each other in promoting the welfare of the societies and the individuals which compose them.

Coöperation of the engineering schools with the industries is now well established. Dean Herman Schneider, the originator of the coöperative idea in engineering education, sees his policy being adopted by new institutions almost every day. Although the form may differ from his, the spirit underlying them is the same. We see the engineer coöperating with the economist in establishing better courses for the training of

men in the matters of highway transportation and construction. The conference representing these interests called by Commissioner Claxton of the Bureau of Education, was a distinct advance and showed clearly the need of closer coöperation along these lines.

The 1920 Meeting.—The program for the 1920 meeting is nearly completed. Especial consideration has been given to the social features which have been outlined in a folder to be mailed to all members of the Society. The papers to be presented are on timely topics and by noted educators. In all ways it seems that it should be one of the best and largest meetings of this Society.

One of the special features of this meeting is the reports of committees. The committees have now been in operation for some years; they have been continued under the general supervision of the Committee on Committees and a summary of their work shows a distinct advance in all branches of engineering education. Discussion and a round table will form additional established features.



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